Fishery Data Series No. 95-11

Catch and Effort Statistics for the Sockeye Salmon Sport Fishery During the Early Run to the Russian River with Estimates of Escapement, 1994

by

Larry E. Marsh

July 1995

Alaska Department of Fish and Game Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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ABSTRACT

A direct expansion creel survey of the early-run Russian River recreational fishery was conducted in 1994 to determine angler effort for and harvest of sockeye salmon *Oncorhynchus nerka*. Anglers expended 178,174 angler-hours to harvest 43,923 sockeye salmon from the early run (11 June-19 July). The weighted harvest rate for the early run was 0.275 sockeye salmon per hour of angler effort. Approximately 73% of the effort and 78% of the harvest during the early run was taken from the confluence area of the fishery.

A total of 44,872 sockeye salmon bound for spawning areas within the Russian River system were counted through the weir at the outlet of Lower Russian Lake during the early run. This escapement number exceeded the Board of Fisheries mandated escapement goal of 16,000 fish.

Estimates of the age composition of the total early-run return (harvest plus escapement) indicate that the return was primarily comprised of age-2.3 and age-1.3 sockeye salmon (69.5% and 21.8%, respectively). Both the sport harvest and total return for the early run were larger than the mean historical values for the time frame 1976-1993.

Key Words: Russian River, sockeye salmon, *Oncorhynchus nerka*, creel survey, direct expansion, harvest, effort, weir, escapement, age composition, recreational fishery, harvest rate.

INTRODUCTION

The Russian River is a clearwater stream located in the central Kenai Peninsula near Cooper Landing, Alaska. The drainage includes two large clearwater lakes, Upper and Lower Russian lakes, and terminates in the Kenai River approximately midway between Kenai and Skilak lakes (Figure 1). One of the largest recreational fisheries for sockeye salmon *Oncorhynchus nerka* in Alaska occurs in the Russian River and at its confluence with the Kenai River. Annual effort by anglers in this fishery has exceeded 450,000 angler-hours and annual harvests have exceeded 190,000 fish. Prior information pertaining to this fishery has been presented by Lawler (1963, 1964), Engel (1965-1972), Nelson (1973-1985), Nelson et al. (1986), Athons and McBride (1987), Hammarstrom and Athons (1988, 1989), Carlon and Vincent-Lang (1990), Carlon et al. (1991), and Marsh (1992-1994).

Sockeye salmon return to the Russian River in two temporal components, termed early and late-runs. Historically, the total return during the early run has averaged approximately one-half that of the total return during the late-run. The early run typically arrives at the confluence of the Russian and Kenai rivers in early June. Early-run fish typically remain in the confluence area for up to 2 weeks before continuing their migration. By mid July, these fish will have migrated through the Russian River and into Upper Russian Lake. The early run spawns almost exclusively in Upper Russian Creek (Nelson 1973, 1974) and is comprised primarily of 3-ocean fish (Nelson 1973-1985, Nelson et al. 1986, Athons and McBride 1987, Hammarstrom and Athons 1988 and 1989, Carlon and Vincent-Lang 1990, Carlon et al. 1991, Marsh 1992-1994).

The early run of sockeye salmon bound for the Russian River is utilized predominantly by the recreational fishery. The run migrates through the waters of Cook Inlet prior to the opening of the commercial fishery which would intercept the stock. Numerically, this stock is much smaller than the later arriving Kenai River mainstem stocks, which include the late-run Russian River sockeye. The early-run fish tend to migrate rapidly through the Kenai River, therefore, minimal harvest and effort occurs in the mainstem Kenai River. As such, all management decisions regarding harvest and stock conservation issues for the early run are focused upon the confluence area of the Kenai and Russian

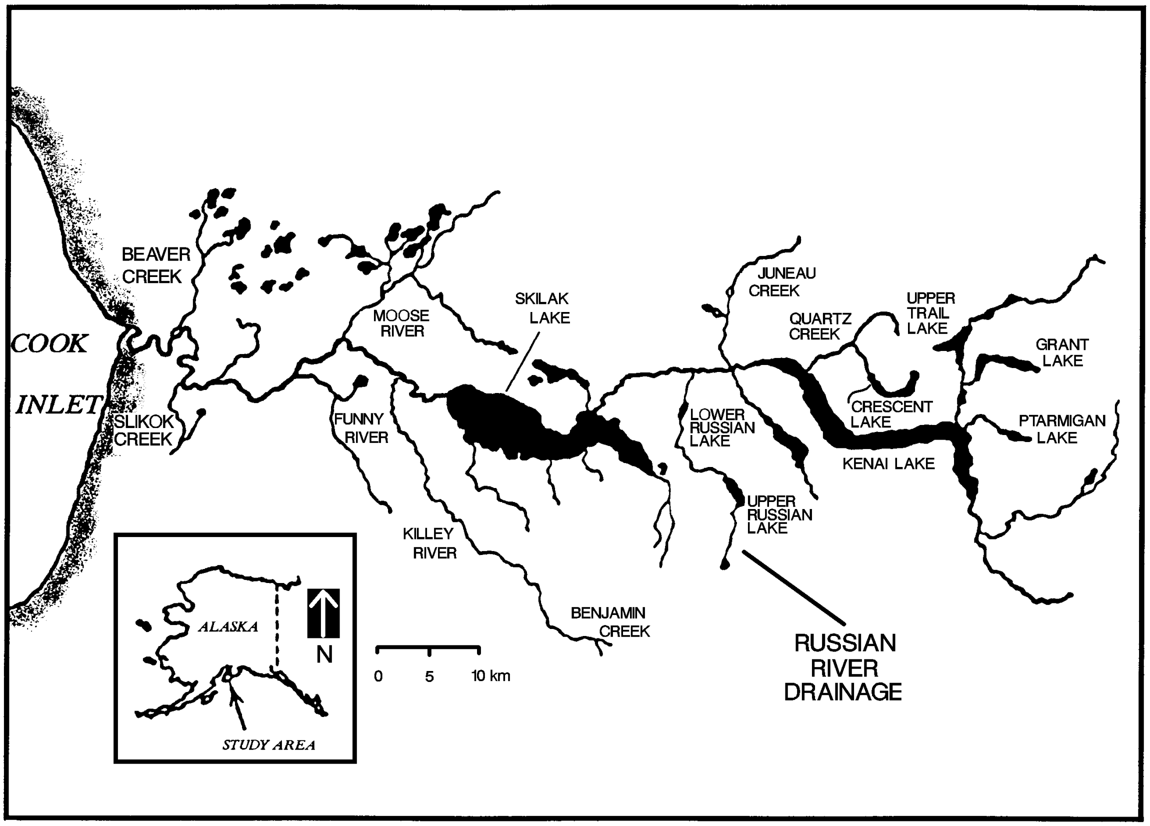

Figure 1.-Map of the Kenai and Russian River drainages.

rivers and a short stretch of the mainstem Russian River.

The Division of Sport Fish of the Department of Fish and Game manages the recreational fishery to ensure that a minimum number of spawning sockeye salmon from each run passes through a weir at the outlet of Lower Russian Lake (Figure 2). The current escapement goal for the early run is 16,000 fish. This goal is based upon evaluation of returns from past brood years. With the exception of 1989, the escapement goal has been achieved each year since the goals were formally adopted in 1979. Despite an emergency closure of the early-run fishery in 1989 (1 July through 15 July), the early-run escapement goal was not achieved (Carlon and Vincent-Lang 1990).

Given that the recreational fishery for sockeye salmon at the Russian River is one of the largest in the state in terms of angler effort, there is a potential for over harvest. Precise and timely management decisions are required to ensure that adequate escapement is obtained. The data necessary for these decisions are provided by a creel survey and a counting weir. The creel survey provides data regarding angler effort and harvest from the recreational fishery which occurs in the Kenai/Russian River "fly-fishing-only" area (Figure 2) and in a short stretch, approximately 4.2 km (2.5 miles), of the mainstem Russian River. Weir operations

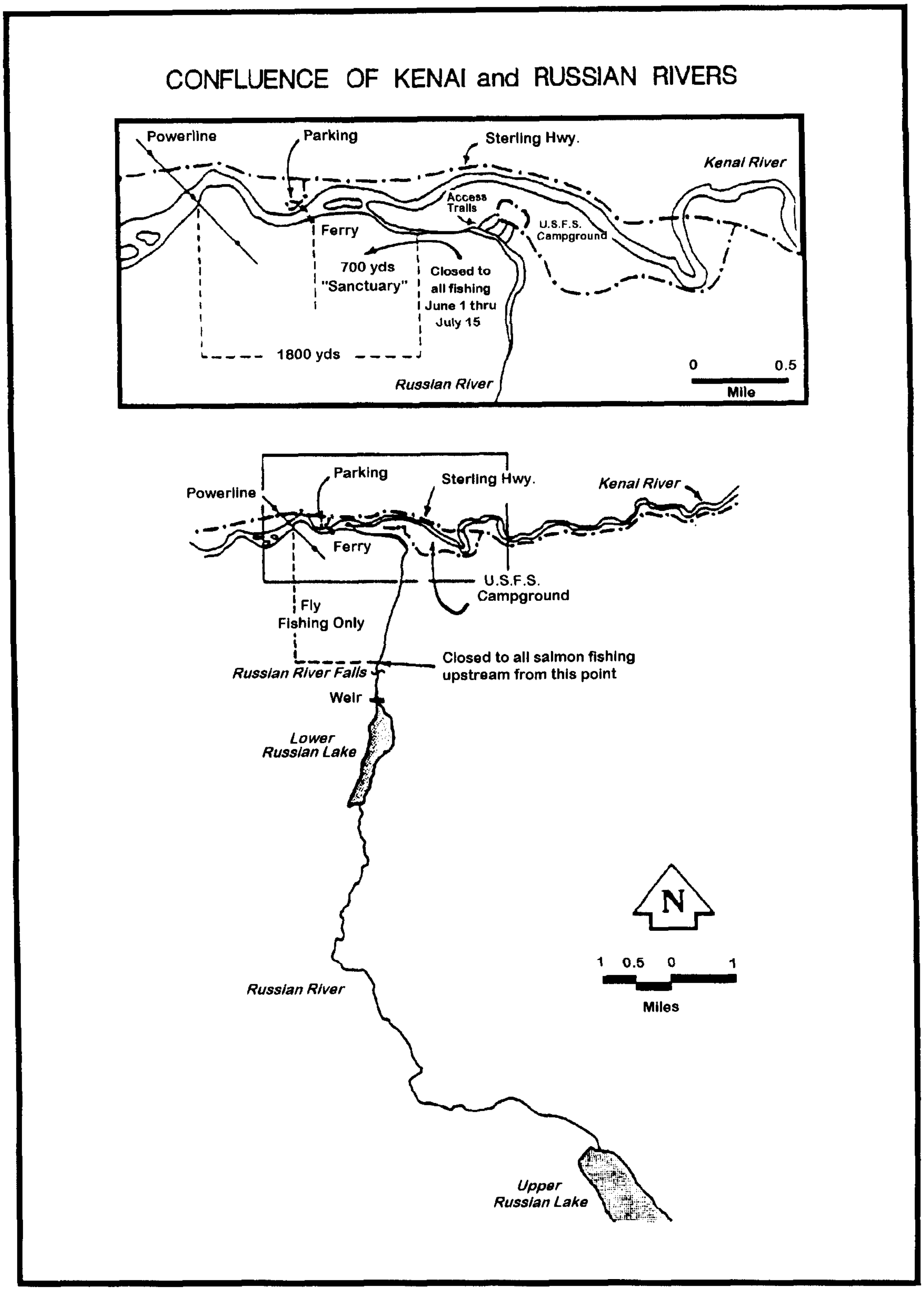

Figure 2.-Detailed map of the Kenai and Russian River study area.

provide daily escapement information. Estimates of the total in-river return (harvest plus escapement) and the age, sex, and size compositions of the return provide necessary information required to evaluate production and to estimate optimum spawning escapement levels.

From 1 June through 20 August 1994, the daily bag and possession limit for sockeye salmon taken from the Kenai/Russian River "fly-fishing-only" area was three fish of 406 mm (16 in) or more in length. Within this area, from a marker located 540 m (600 yd) downstream from the Russian River falls to a marker located on the Kenai River 1,620 m (1,800 yd) downstream from the confluence with the Russian River, only a single-hook unbaited, unweighted fly with a point-to-shank measurement of 9.5 mm (3/8 in) or less constituted legal terminal tackle. Any weights attached to the line were required to be a minimum of 457 mm (18 in) above the hook. Within this "fly-fishing-only" area, there is a sanctuary area which begins in the Russian River 137 m (150 yd) upstream of the confluence with the Kenai River and extends downstream to a marker placed approximately 25 m (75 ft) downstream of the ferry cable (approximately 640 m). This area is closed to all fishing from 1 June to 15 July by regulation.

The objectives of this report are to present for 1994: (1) estimates of effort and harvest of early-run sockeye salmon for the Russian River recreational fishery, (2) estimates of the escapement of the early run of sockeye salmon, and (3) estimates of the age, sex, and length distributions of the harvest and escapement of the early run of sockeye salmon.

METHODS

STUDY AREA

The recreational fishery occurs in two areas (Figure 3): (1) the confluence area, which extends from the upper limit marker of the sanctuary area downstream approximately 1.6 km to a marker on the Kenai River identifying the downstream limit of the "fly-fishing-only" area; and (2) the river area, which extends from the upper limit of the sanctuary area upstream approximately 3.2 km on the Russian River to a marker identifying the upper limit of the "fly-fishing-only" area.

Access to the confluence and river fishing areas is provided primarily at two locations. The United States Forest Service (USFS) campground located on the east side of the Russian River provides four short trails which intersect the main riverside trail affording access to the river area. These trails serve four camping/parking areas within the Russian River Campground. These areas are designated with the following names: (1) Grayling, (2) Rainbow Trout, (3) Pink Salmon, and (4) Red Salmon. Access to the confluence area is primarily through a parking area administered by the United States Fish and Wildlife Service (USFWS) and located on the north bank of the Kenai River directly across from the Russian River confluence. Immediately adjacent to the USFWS parking area is a cable ferry which traverses the Kenai River. Most anglers fishing the confluence area use the ferry to reach the south bank of the Kenai River. Both the parking area and the ferry are operated privately under a concession administered by the USFWS. Some anglers also use the ferry to traverse the Kenai River and then walk upstream to fish the Russian River area and others use the USFS campground trails to gain access to the confluence area.

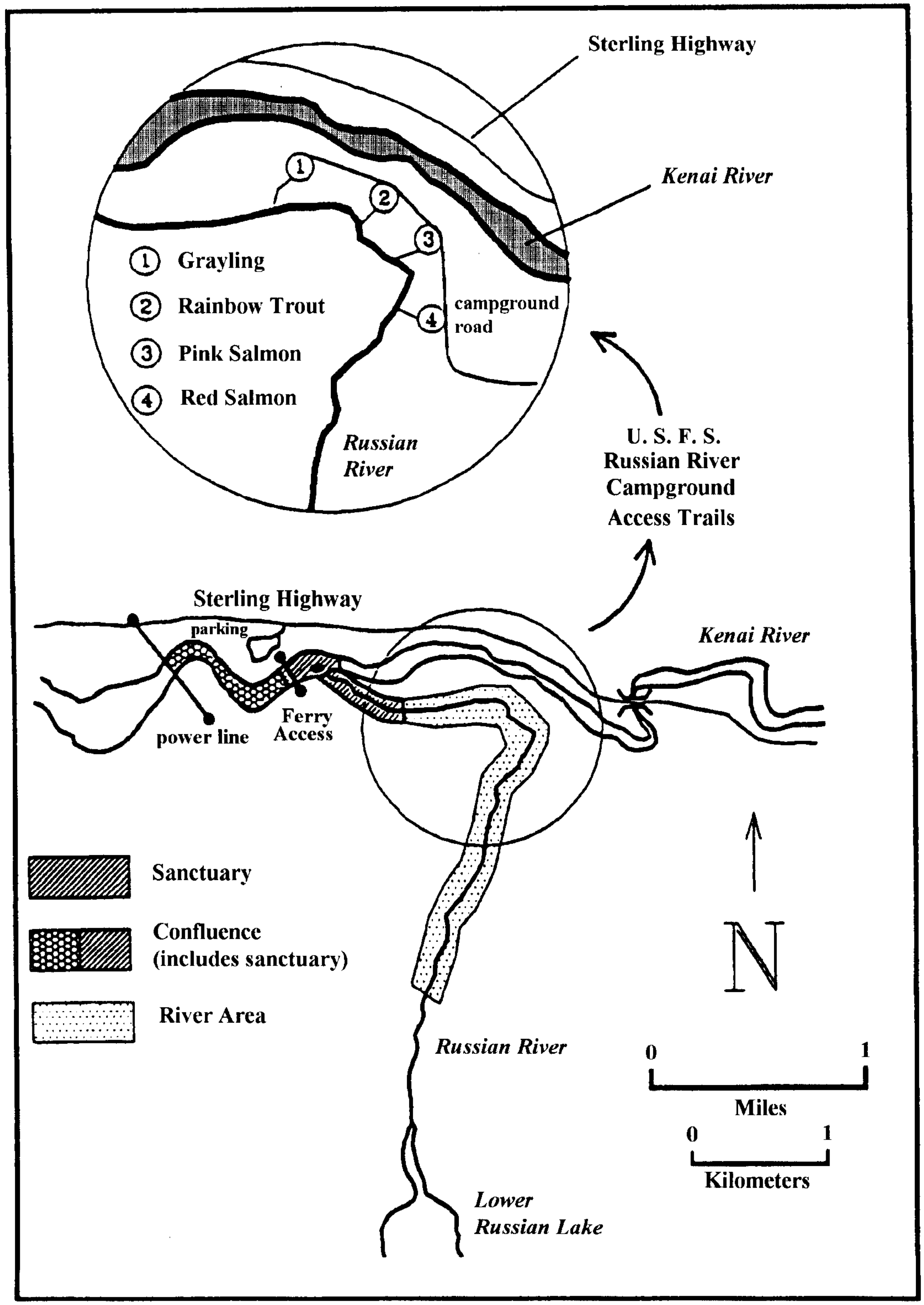

Figure 3.-Map of the Russian River sockeye salmon recreational fishing areas and fishing access locations sampled during the 1994 creel survey.

A stationary weir, constructed of metal and wood, is located just downstream from the outlet of Lower Russian Lake and approximately 360 m (400 yds) upstream from the Russian River falls. The weir has been described in detail by Nelson (1976) and provides a complete count of the early-run spawning escapement.

STUDY DESIGN

Creel Survey

Inseason management of the sport fishery during the past five seasons has utilized the daily harvest rates in conjuction with the current esimated total harvest to track abundance and the harvest potential of the recreational fishery. These estimates, when used in concert with the migratory timing statistics from the historical weir counts have allowed fishery managers to project the final escapement by accounting for the potential harvest, while charting the potential escapement based upon past returns (Vincent-Lang and Carlon 1991).

A direct expansion creel survey was utilized during the 1994 season. This season was the fifth year that this creel survey design has been applied to the Russian River sockeye salmon sport fishery. Previous concerns with biased harvest and effort estimates (Carlon and Vincent-Lang 1990) obtained with a stratified roving creel design (Neuhold and Lu 1957) necessitated a change in creel design beginning with the 1990 season.

Sampling was stratified by access location to estimate harvest and effort for anglers exiting the fishery at each of three sampled access locations. The temporal stratification used to estimate harvest and effort corresponded with the opening of the sanctuary area of the confluence of the Kenai and Russian rivers which influenced catch rates and the subsequent harvest. This occurred on 30 June at 12 noon. Therefore, the data were post-stratified by time. A survey stratum was thus defined as an access location/temporal component combination. The sampled locations included the ferry access to the confluence area and two river trails from the Grayling and Pink Salmon parking areas. These locations were sampled over two temporal components; from 11 June to 29 June and from 30 June to 19 July. Area-specific (river or confluence-area) harvest and effort were estimated for each stratum by recording the area fished for each interviewed angler.

The creel survey sampling day was 18 hours in length (0600 to 2400 hours) and was divided into six, 3-hour periods. A three-stage sampling design was used with days as primary units, periods as secondary units, and anglers as tertiary units. Days were systematically sampled, and within each sampled day, two 3-hour periods were randomly selected from the six possible periods. During each sampled period, anglers were interviewed as they exited the fishery through a sampled location. Thus, all interviews were of completed-trip anglers. All anglers exiting an access location during a sampled period were counted and as many as possible were interviewed for harvest and effort data by area fished (river or confluence area). Anglers exiting a location during a sampled period and not interviewed were prorated as river or confluence anglers based on proportions determined from anglers that were interviewed. Count and interview data were then expanded for each stratum to account for area-specific harvest and effort during periods and days that were not sampled.

During the years 1990 through 1992, approximately two-thirds of the harvest and effort occurred in the confluence area (Carlon et al. 1991, Marsh 1992-1993). Historically, this has been typical of the early-run sport fishery in most years (Nelson et al. 1986). As a result of this concentration of harvest and effort, and because harvest rate (harvest per hour) is used as a management tool to index sockeye salmon abundance at the confluence, the confluence access location (the ferry) was sampled every other day throughout the early run. This ensured that timely information regarding confluence harvest rates was available when formulating in-season management strategies.

Creel survey results from the 1990 and 1991 seasons indicated that angler use patterns differed among the access locations to the sport fishery (Carlon et al. 1991, Marsh 1992). Three access locations, the ferry, Grayling and Pink Salmon, represented more than 90% of the total effort and more than 90% of the total harvest during the annual sport fishery. These locations also contributed approximately 90% of the total variance for both the harvest and effort estimates. Therefore, to better utilize creel survey personnel and improve the precision of the estimates of harvest and effort from the remaining access locations, Rainbow and Red Salmon were dropped from the sampling schedule beginning with the 1992 season. This sampling regime was continued during the 1994 season.

Estimates of effort, harvest, and their variances for the early run in 1990-1994 were used to optimally allocate the number of sampling days among the river access locations (Cochran 1977). In 1994, the ferry was sampled every other day, while Grayling was sampled approximately every 3 days and Pink Salmon sampled approximately every 4 days.

Angler effort and harvest were estimated for a stratified, three-stage (day/period/angler) direct expansion creel survey (Bernard et al. *In prep*). Total effort, harvest, and their variances were estimated for the entire run by summing the stratum (access location) estimates. In addition, the estimates were post-stratified by area fished (river or confluence) and by temporal strata within the run.

At access location k on day i during sample period j, m_{kij} represents those completed anglers interviewed as they exited through location *k* and a_{kij} represents those anglers that exited and were counted but were not interviewed. Interviewed anglers were assigned to one of three groups:

m_{1kij} = anglers that fished the river area only,

m_{2kij} = anglers that fished the confluence area only, or

m_{3kij} = anglers that fished both areas, and,

$$m_{kij} = m_{1kij} + m_{2kij} + m_{3kij} . \qquad (1)$$

Area-specific harvest of missed anglers (a_{kij}) was prorated based on information obtained in interviews. The proportion of missed anglers that fished the river was estimated as:

$$\hat{P}_{rkij} = \frac{m_{rkij}}{m_{kij}} , \qquad (2)$$

where:

m_{rkij} = the number of interviewed anglers fishing the river

= $m_{1kij} + m_{3kij}$.

The number of missed anglers prorated as fishing the river ($\hat{a}_{rkij}$) were estimated as:

$$\hat{a}_{rkij} = a_{kij} \hat{P}_{rkij} . \qquad (3)$$

The total number of anglers fishing the river area and exiting the fishery at location k on day i during sample period j was estimated as:

$$\hat{M}_{rkij} = m_{rkij} + \hat{a}_{rkij} . \qquad (4)$$

The same procedure was used to prorate the missed anglers who fished the confluence area:

$$\hat{M}_{ckij} = m_{ckij} + \hat{a}_{ckij} \quad . \tag{5}$$

The mean river-area harvest per interviewed angler was estimated as:

$$\bar{h}_{rkij} = \frac{\sum_{i=1}^{m_{rkij}} h_{rkijl}}{m_{rkij}} \tag{6}$$

where:

h_{rkijl} = the river-area harvest of angler l at location k on day i during sample period j.

The variance of river-area harvest among interviewed anglers was estimated assuming a normal variate as:

$$\text{Var}\left(\bar{h}_{rkij}\right) = \frac{\sum_{i=1}^{m_{rkij}} \left(h_{rkijl} - \bar{h}_{rkij}\right)^2}{m_{rkij} - 1} \quad . \tag{7}$$

The total river-area harvest of anglers exiting through access location k on day i during sample period j was estimated as:

$$\hat{H}_{rkij} = \hat{M}_{rkij}\bar{h}_{rkij} \quad . \tag{8}$$

The mean river-area harvest per period was then estimated for location k on day i as:

$$\bar{H}_{rki} = \frac{\sum_{j=1}^{u} \hat{H}_{rkij}}{u} \quad , \tag{9}$$

where:

u = the number of sample periods on day i (u = 2),

and the variance among sample periods was estimated as:

$$\text{Var}\left(\bar{H}_{rki}\right) = \frac{\sum_{j=1}^{u} \left(\hat{H}_{rkij} - \bar{H}_{rki}\right)^2}{u - 1} \quad . \tag{10}$$

The total river-area harvest of anglers exiting through access location k on day i was estimated by expanding the mean river-area harvest per period on day i by:

$$\hat{H}_{rki} = U\bar{H}_{rki} \quad , \tag{11}$$

where:

U = the total number of periods on a day (U = 6).

The mean river-area harvest per day was estimated at location k as:

$$\bar{H}_{rk} = \frac{\sum_{i=1}^{d} \hat{H}_{rki}}{d} \quad , \tag{12}$$

where:

d = the number of days sampled.

The variance of river-area harvest among days at location k was estimated using the variance for a systematic sample as:

$$\text{Var}\left(\bar{H}_{rk}\right) = \frac{\sum_{i=2}^{d} \left(\hat{H}_{i} - \hat{H}_{i-1}\right)^2}{2(d-1)} \quad . \tag{13}$$

The total river-area harvest at location k was estimated by expanding the mean harvest per day by:

$$\hat{H}_{rk} = D\bar{H}_{rk} \quad , \tag{14}$$

where:

D = the total number of days during the run.

The variance of the total river-area harvest at location *k* was estimated as:

$$\begin{aligned}
\text{Var}\left(\hat{H}_{rk}\right) = \; & (1-f_1)D^2 \frac{\text{Var}\left(\bar{H}_{rk}\right)}{d} + \\
& D\frac{U^2}{u}(1-f_2)\frac{\sum_{i=1}^{d} \text{Var}\left(\bar{H}_{rki}\right)}{d} + \\
& D_{rk} U \sum_{i=1}^{d} \sum_{j=1}^{u} M_{rkij}^2 (1-f_3) \frac{\text{Var}\left(\bar{h}_{rkij}\right)}{dum_{rkij}} ,
\end{aligned} \tag{15}$$

where:

D_{rk} = the total number of sampling days at location *k* during the run,

f_1 = the finite population correction factor for days (d_{rk}/D_{rk}),

f_2 = the finite population correction factor for periods (u_{rki}/U_{rki}), and

f_3 = the finite population correction factor for anglers (m_{rkij}/M_{rkij}).

These procedures (Equations 2 through 15) were also used to estimate the confluence-area harvest of anglers exiting through each access location. Likewise, the same procedures were used to estimate effort (in angler-hours) expended in the river area and the confluence area by substituting the area-specific hours of effort reported by interviewed anglers for the reported harvest in Equations 2 through 15.

Total harvest and effort were estimated for the run by summing the individual stratum estimates. The variances of the total estimates were calculated as the sum of the variances of the individual stratum estimates.

Daily harvest rates were estimated and used for in-season management as an indicator of sockeye salmon abundance. Regardless of access location, the daily confluence-area harvest rate was based solely on confluence effort and the resultant harvest reported by interviewed anglers. The mean daily harvest rate of the confluence area was estimated as:

$$\overline{HPUE}_c = \frac{\sum_{l=1}^{n_c} HPUE_{cl}}{n_c}, \tag{16}$$

where:

n_c = number of interviewed anglers reporting confluence-area effort, and

$HPUE_{cl}$ = confluence-area harvest per hour of effort for angler l.

The variance of this estimate was calculated as:

$$Var\left(\overline{HPUE}_c\right) = \frac{\sum_{l=1}^{n_c}\left(HPUE_{cl} - \overline{HPUE}_c\right)^2}{n_c\left(n_c - 1\right)}. \tag{17}$$

The same procedure was used to estimate river-area harvest rates.

The overall harvest rate for the early run provides a relative basis for comparing seasonal fishing success among years (Nelson 1985, Hammarstrom and Athons 1988). A harvest rate for the early run was estimated by dividing the total harvest estimate by the total effort estimate. The associated variance was then calculated as the variance of a quotient of two random variables. The same procedure was applied to estimate the harvest rate within each spatial component of the recreational fishery (confluence and river).

Spawning Escapement

The escapement of spawning sockeye salmon to the Russian River drainage was enumerated at the stationary weir at the outlet of Lower Russian Lake. An adjustable gate system allowed fish to be passed individually and counted by the weir operator. During the period of overlap of early and late-runs (mid to late July), fish from each run were subjectively identified by degree of external sexual maturation (body color and kype development) and counted separately. Early in each run, adults have not yet developed the reddish body coloration and large green head with hooked jaws characteristic of more sexually mature fish which pass through the weir later in each run. Therefore, during the period of run overlap at the weir, the last of the early-run fish typically exhibit the reddish body coloration and green heads while the late-run fish have not yet developed these physical characteristics. The period of overlap began on 15 July when late-run fish were intermixed with mature, early-run fish and continued through 1 August, after which early-run fish were no longer present.

Biological Data

Six time and area strata within the Russian River sockeye salmon return were sampled for biological data to estimate the age, sex, and length composition of the early run (Table 1).

Table 1.-Temporal components of the recreational harvest and escapement sampled for age composition during the 1994 early-run Russian River sockeye salmon return.

Return Component	Temporal Strata
Confluence-area harvest	6/11 - 6/29
	6/30 - 7/19
River-area harvest	6/11 - 6/29
	6/30 - 7/19
Escapement through weir	6/11 - 6/29
	6/30 - 8/01

The sampling strata corresponded to those for which harvest was estimated by the creel survey. Schedules of each creel survey clerk allowed for biological sampling of the harvest at least part of each day that angler interviews were conducted. In addition, a full day of sampling was scheduled for one or both creel clerks when fishing effort and harvest were the greatest.

Scales were collected from the preferred area of each sampled fish and placed on adhesive-coated cards (Clutter and Whitesel 1956). The sex and length (measured from the mid-eye to the fork-of-tail to the nearest millimeter) of each sampled fish were also determined and recorded. Scale impressions were made in clear acetate and examined with a microfiche reader for aging. The European method of age description was used to record ages: the numeral preceding the decimal represents the number of freshwater annuli and the numeral following the decimal represents the number of marine annuli. Total age from brood is therefore the sum of the two numbers plus one.

Age and sex composition of the run was estimated for each strata. The proportion of fish of age group g in stratum f was estimated as:

$$\hat{p}_{gf} = \frac{x_{gf}}{n_f}, \tag{18}$$

where:

x_{gf} = the number of legible scales read from sockeye salmon sampled during stratum f and interpreted as age g.

n_f = the total number of legible scales read from sockeye salmon sampled during stratum f.

The variance of this proportion was estimated as (Scheaffer et al. 1979):

$$\mathrm{Var}\left(\hat{p}_{gf}\right) = \frac{\hat{p}_{gf}\left(1 - \hat{p}_{gf}\right)}{n_f - 1}. \tag{19}$$

The age composition by sex of the harvest within each stratum was estimated by:

$$\hat{H}_{gf} = \hat{H}_f \hat{p}_{gf}, \tag{20}$$

where:

H_f = the estimated total harvest of sockeye salmon during stratum f.

The variance of the age composition was estimated as the product of two independent random variables (Goodman 1960):

$$\mathrm{Var}\left(\hat{H}_{gf}\right) = \hat{H}_f^2\,\mathrm{Var}\left(\hat{p}_{gf}\right) + \hat{p}_{gf}^2\,\mathrm{Var}\left(\hat{H}_f\right) - \mathrm{Var}\left(\hat{p}_{gf}\right)\mathrm{Var}\left(\hat{H}_f\right) \quad , \tag{21}$$

where:

$\mathrm{Var}\left(\hat{H}_f\right)$ = the variance of the harvest estimate during stratum f.

Age composition of the total harvest from the confluence and total harvest from the river was estimated by sex by summing the age composition estimates among the temporal strata. The total number of fish of age g in the harvest from the river was estimated as:

$$\hat{H}_{rg} = \sum_{f=1}^{t} \hat{H}_{rgf} \quad , \tag{22}$$

where:

t = the number of strata in the run.

The variance of the estimate was calculated by summing the variances of the individual temporal stratum estimates as:

$$\mathrm{Var}\left(\hat{H}_{rg}\right) = \sum_{f=1}^{t} \mathrm{Var}\left(\hat{H}_{rgf}\right). \tag{23}$$

The proportion of sockeye salmon of age *g* in the total sport harvest from the river was estimated as:

$$\hat{p}_{rg} = \frac{\hat{H}_{rg}}{\hat{H}_r}, \tag{24}$$

where:

$\hat{H}_r$ = the estimated total harvest of sockeye salmon from the river.

The variance of this proportion was estimated as an approximation using the delta method (Seber 1982:7-8) as:

$$\mathrm{Var}\left(\hat{p}_{rg}\right) \approx \frac{1}{\hat{H}_r^2}\left\{\frac{\mathrm{Var}\left(\hat{H}_{r1}\right)\left[\hat{H}_r\hat{p}_{rg1} - \hat{H}_{rg}\right]^2}{\hat{H}_r^2} + \mathrm{Var}\left(\hat{p}_{rg1}\right)\hat{H}_{r1}^2 + \mathrm{Var}\left(\hat{p}_{rg2}\right)\hat{H}_{r2}\right\}, \tag{25}$$

where:

$\hat{H}_{rf}$ and $\mathrm{Var}\left(\hat{H}_{rf}\right)$ = the estimates of harvest and variance of harvest from the river during temporal stratum f,

$\hat{p}_{rgf}$ and $\mathrm{Var}\left(\hat{p}_{rgf}\right)$ = the estimates of proportion and variance of proportion of fish of age g sampled from the harvest from the river during temporal stratum f, and

$\hat{H}_{rgf}$ = the estimated harvest of fish of age g from the river during temporal stratum f.

This proportion and its variance were estimated similarly for the harvest of sockeye salmon from the confluence.

The number of sockeye salmon of age group g of stratum f in the escapement was estimated by sex using the estimates of the age group proportions defined previously:

$$\hat{E}_{gf} = E_f\,\hat{p}_{gf}, \tag{26}$$

where:

E_f = the total number of sockeye salmon enumerated during stratum f at the weir or spawning downstream from the falls.

The variance of $\hat{E}_{gf}$ was estimated as:

$$\mathrm{Var}\left(\hat{E}_{gf}\right) = E_f^2\,\mathrm{Var}\left(\hat{p}_{gf}\right) \quad . \tag{27}$$

The age composition of the entire escapement past the weir was estimated by summing the stratum estimates. The total number of fish of age g migrating through the weir was estimated as:

$$\hat{E}_g = \sum_{f=1}^{t} \hat{E}_{gf} \quad . \tag{28}$$

Similarly, the variance was estimated as the sum of the variances as:

$$\mathrm{Var}\left(\hat{E}_g\right) = \sum_{f=1}^{t} \hat{E}_{gf} \; . \tag{29}$$

The proportion of sockeye salmon of age g in the total escapement migrating through the weir was estimated as:

$$\hat{p}_{eg} = \frac{\hat{E}_g}{E_T}, \tag{30}$$

where:

E_T = the total escapement enumerated at the weir.

The variance of this proportion was estimated by:

$$\mathrm{Var}\left(\hat{p}_{eg}\right) = \frac{\mathrm{Var}\left(\hat{E}_g\right)}{E_T^2}. \tag{31}$$

The total return, total return by age, and their respective variances were estimated by summing the estimates from the total harvest at the confluence and at the river, and from the escapement. The proportion of sockeye salmon of age g in the total return was estimated as:

$$\hat{p}_g = \frac{\hat{N}_g}{\hat{N}_T}, \tag{32}$$

where:

E_T = the total escapement enumerated at the weir.

$\hat{N}_g$ = the estimated total return of fish of age g, and

$\hat{N}_T$ = the estimate of the total return.

The variance of this proportion was estimated as an approximation using the delta method (Seber 1982:7-8) as:

$$\mathrm{Var}\left(\hat{p}_g\right) \approx \frac{1}{\hat{N}_T^2}\left\{ \frac{\mathrm{Var}\left(\hat{H}_c\right)\left[\hat{p}_{cg}\left(\hat{H}_r + E\right) - \left(\hat{H}_{rg} + \hat{E}_g\right)\right]^2}{\hat{N}_T^2} + \frac{\mathrm{Var}\left(\hat{H}_r\right)\left[\hat{p}_{rg}\left(\hat{H}_c + E\right) - \left(\hat{H}_{cg} + \hat{E}_g\right)\right]^2}{\hat{N}_T^2} + \mathrm{Var}\left(\hat{p}_{cg}\right)\hat{H}_c^2 + \mathrm{Var}\left(\hat{p}_{rg}\right)\hat{H}_r^2 + \mathrm{Var}\left(\hat{p}_{eg}\right)E^2 \right\}, \tag{33}$$

where:

$\hat{H}_\bullet$ and $\mathrm{Var}\left(\hat{H}_\bullet\right)$ = the estimates of total harvest and variance of total harvest from the river (= r) or the confluence (= c), and

$\hat{p}_{\bullet g}$ and $\mathrm{Var}\left(\hat{p}_{\bullet g}\right)$ = the estimates of proportion and variance of proportion of fish of age g from the total harvest from the river (= r) or the confluence, or from the escapement (= e).

In prior years, the age composition of the early-run escapement was used to estimate the return by age for both the escapement and early-run harvest at both the confluence and river areas (Nelson 1986, Carlon and Vincent-Lang 1990). This assumed that the age composition of the escapement through the weir represented that of the river and confluence-area sport harvests. This assumption was tested in both 1990 and 1991. Significant differences in age compositions were found among the three sampled areas during some of the temporal strata (Carlon et al. 1991, Marsh 1992). Chi-square tests were used to test the null hypotheses that the age distributions were equal among the three areas and between the two temporal strata. The null hypothesis was rejected if calculated tail-area probabilities were less than 0.05. Failure to reject the null hypothesis would allow the age samples to be pooled to achieve a more precise estimate of the number of sockeye by age in the harvest and escapement.

Mean length at age was estimated for each temporal stratum within each of three spatial strata of the return: the confluence-area harvest, the river harvest, and the weir escapement. Associated variances were estimated using standard normal procedures. An analysis of variance (ANOVA) was used to determine if mean length at age differed by area, temporal strata, and sex. This analysis was conducted for the predominant age groups (age 2.3, 1.3 and 2.2 fish). This analysis was not conducted for age 1.2 due to insufficient samples.

RESULTS

CREEL STATISTICS

Survey Interviews

Sampling began on 11 June at the ferry access location and continued every other day through the end of the early run on 19 July. The systematic sampling of the two Russian River Campground access locations began on 16 June, 5 days after sampling commenced at the ferry location. Because early-run sockeye salmon typically hold in the confluence area before entering the Russian River, harvest and effort are considered negligible until approximately the third week in June. On-site observations and creel data indicated that during the 1994 early run effort and the resulting harvest began somewhat earlier than normal with significant catches evidenced on 15 June.

A total of 6,331 anglers were enumerated as they exited sampled access locations during the 1994 early-run creel survey (Table 2). Of these, 3,848 (61%) were interviewed and 2,483 (39%) were not interviewed. The total number of interviews collected in the early run represents a 35% increase from 1993. The level of creel sampling remains similar to the first year (1990) that the 3-stage direct expansion survey was implemented (Carlon et al. 1991). Most of the interviews (68.0%) were made at the ferry access, as this location was sampled the most intensely. This area typically accounts for most of the sport fishing effort (Appendix A1). Anglers exiting via the ferry location tended to fish the confluence area (94%) (Appendix A2).

Harvest and Effort

Estimates of harvest, effort, and variances are presented by stratum (temporal/access location) in Appendix A3. By examining stratum estimates and the associated variance components by access location, it is possible to determine which access locations most affected the relative precision of early-run estimates of both harvest and effort (Table 3). Of the three access locations, (the ferry, Grayling, and Pink Salmon), the ferry accounted for most of the effort and harvest during the early run (64% and 63%, respectively). The relative precisions of the early-run harvest and effort estimates were both 14% (Table 3). The 1994 early-run harvest estimate was 48,923 (SE = 3,593) sockeye salmon (Table 4). The effort estimate for the early run was 178,174 (SE = 12,693) angler-hours. During the early run, 78% of the harvest was taken from the confluence area and the remaining 22% was taken from the river area (Table 4 and Figure 4).

Harvest per hour of angler effort was 0.293 fish (SE = 0.024) for the confluence area and 0.224 for the river area in 1994 (Table 5).

SPAWNING ESCAPEMENT

A total of 44,872 early-run sockeye salmon passed through the weir (Figure 5 and

Table 2.-Summary of the number of interviews collected during sampled periods for the early-run Russian River creel survey, 1994.

	Area Fished			Total	Anglers Exiting and not	Total Anglers
Exit Location	Confluence	River	Both	Interviews	Interviewed	Exiting
Ferry	2,417	141	49	2,607	1,577	4,184
Grayling	336	551	38	925	739	1,664
Pink Salmon	72	233	11	316	167	483
Total	2,825	925	98	3,848	2,483	6,331

Table 3.-Estimates of harvest, effort, and associated variances by access location for the early-run Russian River sockeye salmon recreational fishery, 1994.

Access Location	Harvest	(%)	Variance of Harvest	(%)	Relative[a] Precision	Effort	(%)	Variance of Effort	(%)	Relative[a] Precision
Ferry	31,204	64	7,847,151	61	18%	112,183	63	135,681,386	84	20%
Grayling	14,845	30	4,626,887	36	28%	47,170	26	18,664,360	12	18%
Pink Salmon	2,874	6	435,006	3	45%	18,821	11	6,757,372	4	27%
Total	48,923	100	12,909,044	100	14%	178,174	100	161,103,118	100	14%

[a] alpha = 0.05

Table 4.-Summary of estimated angler effort and harvest by component during the early-run of Russian River sockeye salmon, 1994.

Component	Confluence Area	River Area	Total	95% Confidence Interval
Effort[a]	130,532	47,642	178,174	153,296 - 203,052
SE	11,868	4,502	12,693	
Harvest	38,271	10,652	48,923	41,881 - 55,965
SE	3,138	1,749	3,593	

[a] Angler-hours.

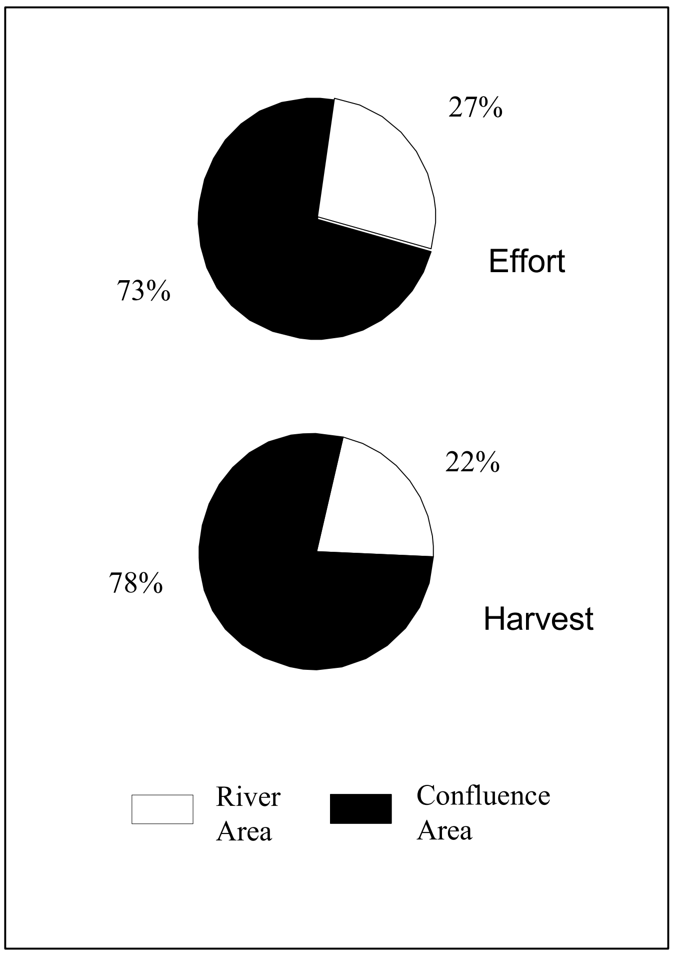

Figure 4.-Harvest and angler effort by area for the Russian River early-run sockeye salmon recreational fishery, 1994.

Table 5.-Estimated harvest per hour of angler effort (HPUE) by anglers interviewed during the early run of the Russian River sockeye salmon recreational fishery, 1994.

Area	Days n[a]	Days N[b]	Number of Interviews[c]	HPUE	Variance of HPUE
Confluence	33	39	2,923	0.293	0.0006
River	26	39	1,023	0.224	0.0013
Both			3,946	0.275	0.0004

[a] Number of days on which at least one angler reported fishing effort.

[b] Number of days possible for conducting interviews.

[c] Anglers who fished both areas are represented twice.

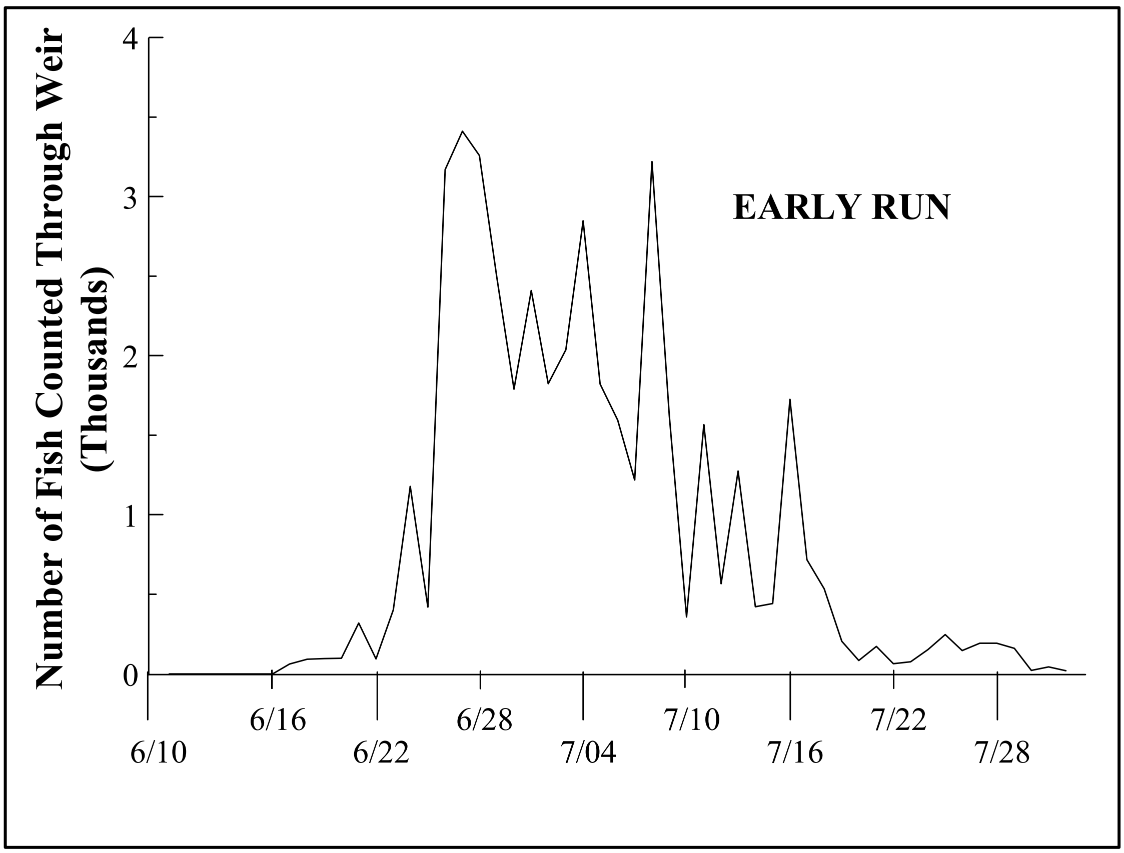

Figure 5.-Daily escapement of sockeye salmon through the Russian River weir, 1994.

Appendix A4). Late-run sockeye salmon began arriving on 15 July and the last early-run fish was passed on 1 August.

BIOLOGICAL DATA

Chi-square tests detected significant differences between two of the three spatial strata (confluence-area harvest, river-area harvest, and weir escapement) during at least one of the temporal strata (Table 6). The age composition of the confluence-area harvest differed from both that of the weir escapement and the river-area harvest during the second temporal strata (Table 6). However, the age composition of the river-area harvest did not significantly differ from that of the weir escapement during either of the temporal strata (Table 6).

Chi-square tests also indicated that age composition changed significantly over time for the harvest from the river and at the weir, but not for the harvest at the confluence (Table 7).

Table 6.-Results of chi-square tests of age composition between spatial strata for the early-run Russian River sockeye salmon return, 1994.

	Spatial Strata		
Temporal Stratum[a]	Confluence Harvest vs. River Harvest	Confluence Harvest vs. Weir Escapement	River Harvest vs. Weir Escapement
1 6/11 - 6/29	df = 2 $\chi^2 = 3.47$, P = 0.18 NS[b] (P > 0.05)	df = 2 $\chi^2 = 9.02$, P = 0.01 S[b] (P < 0.05)	df = 2 $\chi^2 = 3.47$, P = 0.18 NS[b] (P > 0.05)
2 6/30 - 7/19[a]	df = 3 $\chi^2 = 31.12$, P < 0.001 S[b] (P < 0.05)	df = 3 $\chi^2 = 28.05$, P < 0.001 S[b] (P < 0.05)	df = 3 $\chi^2 = 0.50$, P = 0.92 NS[b] (P > 0.05)

[a] 2 = 6/30-8/01 for weir escapement.

[b] NS = No significant difference, S = significant difference

Table 7.-Results of chi-square tests of age composition between temporal strata for the early-run Russian River sockeye salmon return, 1994.

Spatial Stratum	Temporal Strata 11 June to 29 June vs 30 June to 19 July[a]
Confluence	df = 2, $\chi^2 = 5.58$, P = 0.061 Not Significant, P > 0.05
River Harvest	df = 3, $\chi^2 = 27.36$, P < 0.001 Significant, P < 0.05
Weir Escapement	df = 3, $\chi^2 = 9.69$, P = 0.021 Significant, P < 0.05

[a] 6/30 - 8/01 for weir escapement.

Because the age composition of the confluence-area harvest differed from both the river-area harvest and the weir escapement and the age composition changed at two of three sites over time, the sample data for the confluence and river-area harvest and weir escapement were stratified by location and temporal strata. Estimates for each spatial/temporal strata were summed to estimate the age composition of the total return (Tables 8 and 9 and 10).

The early-run escapement was comprised predominantly of two age groups, ages 2.3 and 1.3 (Table 8). A third age group, age 2.2, comprised less than 5% of the escapement with the predominant age group (64.5%) being age 2.3. There was a significant difference ($\chi^2 = 6.44$, df = 1, P = 0.01) in the relative proportions of age-2.3 and -1.3 adults between the two temporal strata at the weir.

The early-run recreational harvest from the confluence area was also comprised of predominantly age-2.3 adults (75.2%) with age-1.3 and age 2.2 adults contributing nearly equal proportions (11.3% and 13.5%, respectively) to the harvest (Table 9).

The early-run recreational harvest from the river area was also comprised of predominantly age 2.3 and 1.3 adults with age 2.3 adults contributing approximately 70.0% to the harvest (Table 10). Significant temporal changes in the age composition of the river-area harvest occurred because the proportion of age-2.3 adults decreased from the first stratum (83.7%) to the second stratum (56.3%), and the proportion of age 1.3 fish increased from the first stratum (12.9%) to the second stratum (37.8%).

There were no significant differences in length at age among areas for the three dominant age classes which were represented in the return: age 2.3 fish, age 1.3 fish and age 2.2 fish (age 2.3: F = 2.65; df = 2, 555; P = 0.07); (age 1.3: F = 0.80; df = 2, 171; P = 0.45) and (age 2.2: F = 2.06; df = 2, 44; P = 0.14). However, age 2.3 sockeye salmon sampled during the first temporal strata were significantly larger than those sampled during the second temporal strata (F = 7.60; df = 1, 555; P = 0.006). In addition, there were significant differences detected among areas over time for age 2.3 fish (F = 3.02; df = 2, 555; P = 0.04) (Table 11)..

TOTAL RETURN STATISTICS

Overall, an estimated 93,795 early-run sockeye salmon returned to the Russian River in 1994 (Table 12). Brood years 1988 (age 2.3) and 1989 (age 1.3 and 2.2) were both significant contributors to the early-run return. However, age 2.3 fish comprised the majority of the return (69.5%). The brood year 1989 contributed 29.9% to the early-run return, with the 1990 (age 1.2) brood year comprising just 0.6% of the return. The 1988 escapement of approximately 50,000 spawners produced approximately 88,000 returning adults (Table 13).

APPLICATION OF THE DATA FOR FISHERY MANAGEMENT

Both the early and late sockeye salmon runs are managed for escapement. Based upon analyses of brood production data (Carlon and Vincent-Lang 1990), a sockeye salmon escapement goal of 16,000 was established by the Board of Fisheries during their 1989 forum. On Friday 24 June 1994, a total of 2,343 sockeye salmon had migrated through the weir with an estimated 750 fish holding immediately downstream from the weir and an estimated 6,000 fish in the falls area. Stream survey estimates indicated an additional 5,000-6,000 fish concentrated in the sanctuary area near the confluence of the Kenai and Russian rivers. Observations of the

Table 8.-Estimated age and sex composition of the early-run sockeye salmon escapement through the Russian River weir, 1994.

Dates		Age Group				
	2.3	1.3	2.2	2.1	1.2	Total
6/11 - 6/29						
n[a]= 111						
Count= 15,099						
Females						
Sample Size	41	8	0	0	0	49
Percent	36.9	7.2	0.0	0.0	0.0	44.1
Variance of Percent	21.2	6.1	0.0	0.0	0.0	22.4
Number	5,577	1,088	0	0	0	6,665
Variance of Number	482,769	138,607	0	0	0	511,029
Males						
Sample Size	43	16	3	0	0	62
Percent	38.7	14.4	2.7	0.0	0.0	55.9
Variance of Percent	21.6	11.2	2.4	0.0	0.0	22.4
Number	5,849	2,176	408	0	0	8,434
Variance of Number	491,853	255,683	54,501	0	0	511,029
Sexes Combined						
Sample Size	84	24	3	0	0	111
Percent	75.7	21.6	2.7	0.0	0.0	100.0
Variance of Percent	16.7	15.4	2.4	0.0	0.0	
Number	11,426	3,265	408	0	0	15,099
Variance of Number	381,505	351,227	54,501	0	0	

-continued-

Table 8.-Page 2 of 3.

	Age Group					
Dates	2.3	1.3	2.2	2.1	1.2	Total
6/30-8/01						
n[a]= 182						
Count= 29,773						
Females						
Sample Size	61	31	4	0	2	98
Percent	33.5	17.0	2.2	0.0	1.1	53.8
Variance of Percent	12.3	7.8	1.2	0.0	0.6	13.7
Number	9,979	5,071	654	0	327	16,032
Variance of Number	1,091,287	692,090	105,270	0	53,226	1,217,108
Males						
Sample Size	46	31	6	0	1	84
Percent	25.3	17.0	3.3	0.0	0.5	46.2
Variance of Percent	10.4	7.8	1.8	0.0	0.3	13.7
Number	7,525	5,071	982	0	164	13,741
Variance of Number	924,955	692,090	156,131	0	26,761	1,217,108
Sexes Combined						
Sample Size	107	62	10	0	3	182
Percent	58.8	34.1	5.5	0.0	1.6	100.0
Variance of Percent	13.4	12.4	2.9	0.0	0.9	
Number	17,504	10,142	1,636	0	491	29,773
Variance of Number	1,186,503	1,100,010	254,303	0	79,396	

-continued-

Table 8.-Page 3 of 3.

	Age Group					
Dates	2.3	1.3	2.2	2.1	1.2	Total
EarlyRunTotal						
n[a]= 293						
Count= 44,872						
Females						
Percent	34.7	13.7	1.5	0.0	0.7	50.6
Variance of Percent	7.8	4.1	0.5	0.0	0.3	8.6
Number	15,556	6,159	654	0	327	22,697
Variance of Number	1,574,056	830,697	105,270	0	53,226	1,728,137
Males						
Percent	29.8	16.2	3.1	0.0	0.4	49.4
Variance of Percent	7.0	4.7	1.0	0.0	0.1	8.6
Number	13,374	7,248	1,390	0	164	22,175
Variance of Number	1,416,808	947,773	210,631	0	26,761	1,728,137
SexesCombined						
Percent	64.5	29.9	4.6	0.0	1.1	100.0
Variance of Percent	7.8	7.2	1.5	0.0	0.4	
Number	28,930	13,407	2,044	0	491	44,872
Variance of Number	1,568,009	1,451,238	308,804	0	79,396	

[a] n = sample size.

Table 9.-Estimated age and sex composition of early-run sockeye salmon harvested in the confluence area of the Russian River recreational fishery, 1994

	Age Group					
Dates	2.3	1.3	2.2	2.1	1.2	Total
6/11-6/29						
n[a]= 88						
Harvest= 13,196						
Var(Harvest)= 1,631,981						
Females						
Sample Size	33	0	2	0	0	35
Percent	37.5	0.0	2.3	0.0	0.0	39.8
Variance of Percent	26.9	0.0	2.6	0.0	0.0	27.5
Number	4,949	0	300	0	0	5,248
Variance of Number	694,213	0	44,882	0	0	733,115
Males						
Sample Size	41	7	5	0	0	53
Percent	46.6	8.0	5.7	0.0	0.0	60.2
Variance of Percent	28.6	8.4	6.2	0.0	0.0	27.5
Number	6,148	1,050	750	0	0	7,948
Variance of Number	847,648	155,502	111,526	0	0	1,066,930
Sexes Combined						
Sample Size	74	7	7	0	0	88
Percent	84.1	8.0	8.0	0.0	0.0	100.0
Variance of Percent	15.4	8.4	8.4	0.0	0.0	
Number	11,097	1,050	1,050	0	0	13,196
Variance of Number	1,419,279	155,502	155,502	0	0	1,631,981

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Table 9.-Page 2 of 3.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
6/30-7/19						
n^a= 146						
Harvest= 25,075						
Var(Harvest)= 8,216,658						
Females						
Sample Size	62	10	10	0	0	82
Percent	42.5	6.8	6.8	0.0	0.0	56.2
Variance of Percent	16.8	4.4	4.4	0.0	0.0	17.0
Number	10,648	1,717	1,717	0	0	14,083
Variance of Number	2,527,345	311,592	311,592	0	0	3,645,526
Males						
Sample Size	41	9	14	0	0	64
Percent	28.1	6.2	9.6	0.0	0.0	43.8
Variance of Percent	13.9	4.0	6.0	0.0	0.0	17.0
Number	7,042	1,546	2,404	0	0	10,992
Variance of Number	1,512,281	278,770	446,572	0	0	2,632,514
Sexes Combined						
Sample Size	103	19	24	0	0	146
Percent	70.5	13.0	16.4	0.0	0.0	100.0
Variance of Percent	14.3	7.8	9.5	0.0	0.0	
Number	17,690	3,263	4,122	0	0	25,075
Variance of Number	4,978,644	623,608	809,880	0	0	8,216,658

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Table 9.-Page 3 of 3.

	Age Group					
Dates	2.3	1.3	2.2	2.1	1.2	Total
Early Run Total						
n[a]= 234						
Harvest= 38,271						
Var(Harvest)= 9,848,639						
Females						
Percent	40.8	4.5	5.3	0.0	0.0	50.5
Variance of Percent	10.4	1.9	2.2	0.0	0.0	10.6
Number	15,597	1,717	2,017	0	0	19,332
Variance of Number	3,221,558	311,592	356,474	0	0	4,378,642
Males						
Percent	34.5	6.8	8.2	0.0	0.0	49.5
Variance of Percent	9.4	2.7	3.3	0.0	0.0	10.6
Number	13,190	2,595	3,154	0	0	18,939
Variance of Number	2,359,930	434,272	558,098	0	0	3,699,443
Sexes Combined						
Percent	75.2	11.3	13.5	0.0	0.0	100.0
Variance of Percent	8.0	4.4	5.1	0.0	0.0	0.0
Number	28,787	4,313	5,172	0	0	38,271
Variance of Number	6,397,923	779,110	965,382	0	0	9,848,639

[a] n = sample size.

Table 10.-Estimated age and sex composition of early-run sockeye salmon harvested in the river area of the Russian River recreational fishery, 1994.

	Age Group					
Dates	2.3	1.3	2.2	2.1	1.2	Total
6/11-6/29						
n[a]= 147						
Harvest= 5,328						
Var(Harvest)= 1,764,699						
Females						
Sample Size	52	6	3	0	0	61
Percent	35.4	4.1	2.0	0.0	0.0	41.5
Variance of Percent	15.7	2.7	1.4	0.0	0.0	16.6
Number	1,885	217	109	0	0	2,211
Variance of Number	262,509	10,079	4,380	0	0	348,144
Males						
Sample Size	71	13	2	0	0	86
Percent	48.3	8.8	1.4	0.0	0.0	58.5
Variance of Percent	17.1	5.5	0.9	0.0	0.0	16.6
Number	2,573	471	72	0	0	3,117
Variance of Number	457,208	28,501	2,774	0	0	648,263
Sexes Combined						
Sample Size	123	19	5	0	0	147
Percent	83.7	12.9	3.4	0.0	0.0	100.0
Variance of Percent	9.4	7.7	2.3	0.0	0.0	
Number	4,458	689	181	0	0	5,328
Variance of Number	1,260,420	50,004	8,033	0	0	1,764,699

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Table 10.-Page 2 of 3.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
6/30-7/19						
n[a]= 135						
Harvest= 5,324						
Var(Harvest)= 1,295,706						
Females						
Sample Size	39	32	4	0	1	76
Percent	28.9	23.7	3.0	0.0	0.7	56.3
Variance of Percent	15.3	13.5	2.1	0.0	0.5	18.4
Number	1,538	1,262	158	0	39	2,997
Variance of Number	149,604	109,308	6,941	0	1,555	460,309
Males						
Sample Size	37	19	2	0	1	58
Percent	27.4	14.1	1.5	0.0	0.7	43.7
Variance of Percent	14.8	9.0	1.1	0.0	0.5	18.4
Number	1,459	749	79	0	39	2,327
Variance of Number	137,491	50,077	3,231	0	1,555	297,146
Sexes Combined						
Sample Size	76	51	6	0	2	135
Percent	56.3	37.8	4.4	0.0	1.5	100.0
Variance of Percent	18.4	17.5	3.2	0.0	1.1	
Number	2,997	2,011	237	0	79	5,324
Variance of Number	460,309	232,368	11,132	0	3,231	1,295,706

-continued-

Table 10.-Page 3 of 3.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
Early Run Total						
n[a]= 282						
Harvest= 10,652						
Var(Harvest)= 3,060,405						
Females						
Percent	32.1	13.9	2.5	0.0	0.4	48.9
Variance of Percent	7.9	5.5	0.9	0.0	0.1	9.6
Number	3,423	1,479	266	0	39	5,208
Variance of Number	412,113	119,387	11,322	0	1,555	808,453
Males						
Percent	37.9	11.5	1.4	0.0	0.4	51.1
Variance of Percent	9.7	3.7	0.5	0.0	0.1	9.6
Number	4,033	1,220	151	0	39	5,444
Variance of Number	594,698	78,578	6,004	0	1,555	945,409
Sexes Combined						
Percent	70.0	25.3	3.9	0.0	0.7	100.0
Variance of Percent	9.8	8.7	1.4	0.0	0.3	0.0
Number	7,455	2,700	418	0	79	10,652
Variance of Number	1,720,730	282,371	19,165	0	3,231	3,060,405

[a] n = sample size.

Table 11.-Mean length (millimeters) at age, by sex, for the early run of sockeye salmon sampled from the Russian River, 1994.

			Age											
			2.3			2.2			1.3			1.2		
Date	Component	Sex	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
6/11-6/29	Confluence	F	33	575	3.3	2	600							
		M	41	578	2.7	5	523	15.2	7	574	1.3			
	River	F	52	577	3.2	3	536	27.4	6	576	4.5			
		M	71	576	2.5	2	580	40.0	13	578	5.7			
	Escapement[a]	F	41	576	2.8				8	575	5.1			
		M	43	577	3.0	3	523	19.0	16	573	3.6			
6/30-8/01	Confluence	F	62	566	2.8	10	524	8.5	10	587	7.0			
		M	41	571	3.6	14	539	6.9	9	571	8.3			
	River	F	39	567	3.5	4	540	16.3	32	569	3.1	1	531	
		M	37	572	3.4	2	583	35.0	19	572	3.3	1	516	
	Escapement[a]	F	53	577	2.6	3	530	16.5	25	572	3.4	2	546	13.5
		M	34	580	3.5	4	539	12.5	24	571	4.9			

[a] Fish sampled through the weir at the outlet of Lower Russian Lake.

Table 12.-Estimated age and sex composition of the early run of sockeye salmon to the Russian River, 1994.

	Age Group					
Dates	2.3	1.3	2.2	2.1	1.2	Total
6/11-7/19						
Early Run Total[a] n[b] = 809						
Females						
Percent	36.9	10.0	3.1	0.0	0.4	50.4
Variance of Percent	3.7	1.4	0.5	0.0	0.0	3.8
Number	34,576	9,356	2,938	0	367	47,237
Variance of Number	5,207,727	1,261,675	473,066	0	54,782	6,915,232
Males						
Percent	32.6	11.8	5.0	0.0	0.2	49.6
Variance of Percent	3.3	1.6	0.8	0.0	0.0	3.8
Number	30,597	11,064	4,695	0	203	46,558
Variance of Number	4,371,436	1,460,623	774,733	0	28,316	6,372,990
Sexes Combined						
Percent	69.5	21.8	8.1	0.0	0.6	100.0
Variance of Percent	3.3	2.6	1.3	0.0	0.0	0.0
Number	65,172	20,420	7,633	0	570	93,795
Variance of Number	9,686,661	2,512,719	1,293,351	0	82,627	12,909,044

[a] Confluence-area harvest plus river-area harvest plus escapement through the weir.

[b] n = sample size.

Table 13.-Summary of returns from each brood year, early-run Russian River sockeye salmon, 1974 - 1994.

Year	Spawning Escapement	Return Age 1.2	2.1	1.3	2.2	2.3	Misc. (1.1,1.4)	Measured Return To Date	Return Per Spawner
1974	13,164	(1978) 216	(1978) 0	(1979) 1,264	(1979) 5,873	(1980) 45,495	0	52,848	4.01
1975	5,644	(1979) 0	(1979) 0	(1980) 4,528	(1980) 2,403	(1981) 7,200	0	14,131	2.50
1976	14,735	(1980) 3,465	(1980) 0	(1981) 15,787	(1981) 7,025	(1982) 89,131	0	115,408	7.83
1977	16,061	(1981) 1,848	(1981) 0	(1982) 1,087	(1982) 362	(1983) 14,218	0	17,515	1.09
1978	34,240	(1982) 0	(1982) 0	(1983) 11,055	(1983) 828	(1984) 5,118	0	17,001	0.50
1979	19,742	(1983) 3,311	(1983) 0	(1984) 56,173	(1984) 389	(1985) 34,963	0	94,836	4.80
1980	28,616	(1984) 3,110	(1984) 0	(1985) 3,201	(1985) 4,101	(1986) 31,989	0	42,401	1.48
1981	21,142	(1985) 430	(1985) 0	(1986) 9,969	(1986) 21,734	(1987) 43,907	0	76,040	3.60
1982	56,106	(1986) 7,602	(1986) 0	(1987) 162,686	(1987) 9,120	(1988) 98,771	0	278,179	4.96
1983	21,268	(1987) 0	(1987) 0	(1988) 3,981	(1988) 1,653	(1989) 17,915	0	23,549	1.11

-continued-

Table 13.-Page 2 of 2.

Year	Spawning Escapement	Return Age 1.2	2.1	1.3	2.2	2.3	Misc. (1.1,1.4)	Measured Return To Date	Return Per Spawner
		(1988)	(1988)	(1989)	(1989)	(1990)			
1984	28,899	842	0	4,148	4,324	33,543	0	42,857	1.48
		(1989)	(1989)	(1990)	(1990)	(1991)			
1985	30,601	236	0	196	22,515	20,692	137	43,776	1.43
		(1990)	(1990)	(1991)	(1991)	(1992)			
1986	36,336	540	0	43,166	3,335	43,596	0	90,637	2.49
		(1991)	(1991)	(1992)	(1992)	(1993)			
1987	61,513	30,347	0	266	23,145	55,457	0	109,215	1.78
		(1992)	(1992)	(1993)	(1993)	(1994)			
1988	50,406		622	511	21,305	65,172	238	87,848	1.74
		(1993)	(1993)	(1994)	(1994)	(1995)			
1989	15,338	465	0	20,420	7,633			28,518	1.86
		(1994)	(1994)	(1995)	(1995)	(1996)			
1990	25,144	570	0					570	0.02
		(1995)	(1995)	(1996)	(1996)	(1997)			
1991	32,389							0	0.00
		(1996)	(1996)	(1997)	(1997)	(1998)			
1992	37,117							0	0.00
		(1997)	(1997)	(1998)	(1998)	(1999)			
1993	39,857							0	0.00
		(1998)	(1998)	(1999)	(1999)	(2000)			
1994	44,872								

sport fishery in conjunction with harvest data from the sport fishery documenting an HPUE of .500 in the river area indicated that the sport fishery was quite strong in the vicinity of the sanctuary area, and that fish were beginning to "stack up" in response to the elevated flows and high water levels. Estimated water flows recorded at the weir indicated that the higher than normal rainfall of the previous several days had increased the river flow to nearly 400 ft^3/s, which poses a migratory barrier to sockeye salmon attempting to navigate the Russian River falls. With daily escapement figures averaging a hundred fish or less since 10 June, and the cumulative escapement totaling slightly more than two thousand fish, concerns that anglers would harvest significant numbers of fish holding in the sanctuary area of the Russian River loomed paramount. Therefore, management action to open the fish-pass near the Russian River falls was made on Saturday, 25 June. Total escapement through the weir jumped to nearly 6,000 fish within 24 hours of opening the fish-pass. Further stream surveys indicating 5,000-6,000 fish in the falls area combined with daily average escapements of 3,000 fish, allowed the projection of the necessary escapement goal of 16,000 fish by Thursday, 30 June.

Since the escapement goal was assured, the decision to open the sanctuary area at the confluence of the Kenai and Russian rivers was deemed appropriate. Therefore, the fishery was liberalized by removing the no-fishing restriction on the sanctuary area on Thursday, June 30, at 12:00 p.m. Anglers were therefore afforded increased fishing opportunity in 1994.

DISCUSSION

RELATIVE RUN STRENGTH

The strength of the 1994 early run, as determined from total return estimates (harvest plus escapement), exceeded the historical average (1976-1993) (Figure 6). This return maintains the trend, beginning in 1978, of greater numbers of early-run sockeye salmon returning to the Russian River system.

SAMPLE DESIGN

Creel Survey

An underlying assumption necessary for accurate harvest estimates is that most, if not all, anglers exit the fishery through one of the three sampled access locations. While anglers were observed using other exit locations, the level at which this occurred during 1994 appeared insignificant. Creel survey personnel and the project leader maintained an informal accounting of the use of the other access sites at least twice a day during transit between other sites and during a shift change. However, the number of anglers fishing the mainstem Kenai River on the highway side, and therefore unsurveyed, continued to be significant during the 1994 early run. During the early run, all fish caught in the mainstem

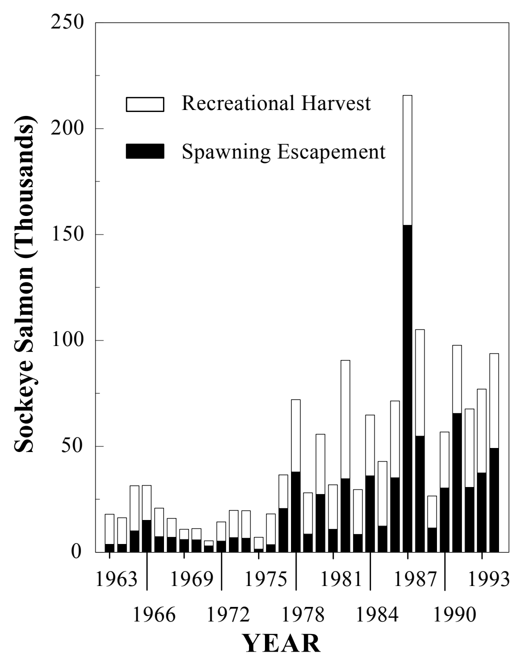


Figure 6.-Historical returns of early-run sockeye salmon to the Russian River.

Kenai River are believed to be of Russian River origin, as no other stock is believed to be present at that time. The addition of a formal monitoring schedule might be appropriate if the number of anglers utilizing the highway side of the Kenai River continues to expand.

Observations of angler activity during the unsampled hours of 0000 to 0600 hours indicated that small numbers of fishermen were engaged in fishing at those hours during 1994. Once again, an informal accounting of the activity during these hours was accomplished through interviews with the angling public and frequent queries of the campground and ferry employees. Additionally, the project staff were instructed to maintain field notes in order to record the number of anglers observed fishing during non-surveyed hours. Generally, such observations occurred just prior to beginning the early morning shift (0600 hrs.) or after the completion of the sampling day (2400 hrs.). Further observations were made when project staff conducted personal fishing trips during non-surveyed hours. However, random observations of access locations during the nighttime period should be continued in the future. This will provide additional information regarding any possible changes in angler use patterns which might prove useful in further refining the survey.

Age Composition

The accurate assessment of the age composition of the sockeye salmon return is needed to establish accurate brood tables for the Russian River system. The sampling of time and area strata adopted in 1990 was continued in 1994. This increase in sampling intensity over prior years is an effort to achieve more accurate age composition estimates. Significant temporal changes in age composition have been detected as well as differences among spatial strata within temporal strata since 1990 (Carlon et al. 1991, Marsh 1992-1994).

Statistical comparisons of the early-run age composition of the harvests and the weir escapement revealed that differences continued to occur in 1994. Therefore, it was not appropriate to use the age composition from one area to estimate the age composition of the total return. The age composition of the return was estimated separately among areas and temporal strata.

Because changes in the age composition of the early run were detected over time and among areas in 1994, sampling of the individual spatial strata should continue at the present sampling intensity. This will improve both estimating the number of sockeye salmon returning by age and sex and evaluating those differences over time. The end result will be improved accuracy of brood production information necessary for the long term management of the Russian River system.

Management of the Fishery

The utilization of migratory timing statistics derived from weir counts and fishery harvest rates should continue (Vincent-Lang and Carlon 1991). The technique of fitting a migratory timing distribution function to count and harvest rate data has been used successfully in the Kenai River to project escapements of chinook salmon (McBride et al. 1989) and was adapted from techniques used to quantify migratory timing of chinook salmon in the Yukon River drainage (Mundy 1982). It is recommended that this technique should be again utilized in 1995 and subsequent years to further evaluate its value in managing the Russian River sockeye salmon resource.

ACKNOWLEDGMENTS

Steve Hammarstrom continued to provide consistent, critical review and assistance. Steve contributed much of the design work and preliminary fabrication of the new, replacement aluminum weir panels installed after nearly twenty years of using the old, wood and steel panels. Steve has also provided a reasoned voice of experience regarding all aspects of the project, from personnel matters to migratory timing influences, which contributed greatly towards my understanding of the project and the fishery resource.

Larry DuBois operated the Russian River weir and field camp. Larry collected biological data and assisted with the ground escapement counts and sampling surveys. Larry has been employed by the Department of Fish and Game during the past four seasons at the Russian River weir. During that time, he has provided important initiative and skills towards constructing, refurbishing and making the field camp a much safer and enjoyable place to conduct the necessary research of studying the salmon resources of the Russian River drainage.

Paul Zallek collected creel survey data and age, sex, and length data from the fishery and monitored the fishery for regulation violations. Paul has been employed by the Department of Fish and Game at the Russian River for the last six seasons. His observations of the fishery were important to the conduct of the creel survey and the management of the sockeye salmon resource.

Colleen O'Brien also collected creel survey data and age, sex, and length data from the fishery. Colleen has also been a long term seasonal employee at the Russian River with five seasons employment. Colleen’s experience with the sport fishery and her continuing, positive, “can do” enthusiasm while performing her responsibilities have proven to be an invaluable asset to the Russian River project.

Dave Athons provided vital aircraft logistical support and assisted with installing and removing the weir structures. His experience at the weir and knowledge of the sport fishery were also valuable towards the day-to-day operations of the study.

Jim Hasbrouck provided necessary statistical review of the data analysis required to estimate the age compositions of the sport harvest and the escapement as well as much appreciated critical review.

Jay Carlon provided indispensable technical support and preliminary data analysis review.

Dave Nelson provided valuable guidance and a long-term perspective towards achieving project objectives.

Sandy Sonnichsen wrote and streamlined the SAS statistical analysis code necessary to generate harvest and effort estimates for the direct expansion creel design used for the Russian River project.

LITERATURE CITED

Athons, D. E. and D. N. McBride. 1987. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimates of escapement, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 7, Juneau.

Bernard, D. R., A. Bingham, and M. Alexandersdottir. *In prep*. The mechanics of conducting on-site creel surveys in Alaska. Alaska Department of Fish and Game, Special Publication, Anchorage.

Carlon, J. A. and D. Vincent-Lang. 1990. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimate of escapement, 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-21, Anchorage.

LITERATURE CITED (Continued)

Carlon, J. A., D. Vincent-Lang, and M. Alexandersdottir. 1991. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimate of escapement, 1990. Alaska Department of Fish and Game, Fishery Data Series No. 90-26, Anchorage.

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bull. Int. Pac. Salmon Fish. Comm. No. 9.

Cochran, W. G. 1977. Sampling techniques, third edition. John Wiley and Sons, Inc. New York.

Engel, L. J. 1965. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1964-1965, Project F-5-R-6, 6 (7-A):111-127, Juneau.

Engel, L. J. 1966. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1965-1966, Project F-5-R-7, 7 (7-A):59-78, Juneau.

Engel, L. J. 1967. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1966-1967, Project F-5-R-8, 8 (7-A):73-81, Juneau.

Engel, L. J. 1968. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9 (7-A):95-116, Juneau.

Engel, L. J. 1969. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1968-1969, Project F-9-1, 10 (7-A):111-130, Juneau.

Engel, L. J. 1970. Studies of the Russian River red salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1969-1970, Project F-9-2, 11 (7-C-2):129-134, Juneau.

Engel, L. J. 1971. Studies of the Russian River red salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1970-1971, Project F-9-3, 12 (G-II-G):79-89, Juneau.

Engel, L. J. 1972. Studies of the Russian River red salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1971-1972, Project F-9-4, 13 (G-II-G):1-14, Juneau.

Goodman, L. A. 1960. On the exact variance of products. Journal of American Statistical Association 66:708-713.

Hammarstrom, S. and D. Athons. 1988. Catch and effort statistics for the sockeye salmon *Oncorhynchus nerka* sport fishery in the Russian River with estimate of escapement, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 41, Juneau.

Hammarstrom, S. and D. Athons. 1989. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimate of escapement, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 88, Juneau.

Lawler, R. R. 1963. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1962-1963, Project F-5-4-4, 4 (6-A):145-160, Juneau.

Lawler, R. R. 1964. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1963-1964, Project F-6-R-5, 5 (6-A):112-122, Juneau.

LITERATURE CITED (Continued)

Marsh, L. E. 1992. Catch and effort statistics for the sockeye salmon sport fishery during the early-run to the Russian River with estimates of escapement, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-22.

Marsh, L. E. 1993. Catch and effort statistics for the sockeye salmon sport fishery during the early-run to the Russian River with estimates of escapement, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-28.

Marsh, L. E. 1994. Catch and effort statistics for the sockeye salmon sport fishery during the early-run to the Russian River with estimates of escapement, 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-16.

Marsh, L. E. *In prep*. Catch and effort statistics for the sockeye salmon sport fishery during the late run to the Russian River with estimates of escapement, 1994. Alaska Department of Fish and Game, Fishery Data Series.

McBride, D., M. Alexandersdottir, S. Hammarstrom, and D. Vincent-Lang. 1989. Development and implementation of an escapement goal policy for the return of chinook salmon to the Kenai River. Alaska Department of Fish and Game, Fishery Manuscript Series No. 8, Juneau.

Mundy, P. R. 1982. Migratory timing of adult chinook salmon (*Oncorhynchus tshawytscha*) in the lower Yukon, Alaska with respect to fisheries management. Technical Report No. 82-1. Department of Oceanography. Old Dominion University. Norfolk, Virginia.

Nelson, D. C. 1973. Studies on Russian River sockeye salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1972-1973, Project F-9-5, 14 (G-II-G):1-26, Juneau.

Nelson, D, C. 1974. Studies on Russian River sockeye salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1973-1974, Project F-9-6, 15 (G-II-G):21-48, Juneau.

Nelson, D, C. 1975. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1974-1975, Project AFS-44, 16 (AFS-44-1):1-41, Juneau.

Nelson, D, C. 1976. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1975-1976, Project AFS-44, 17 (AFS-44-2):1-54, Juneau.

Nelson, D, C. 1977. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1976-1977, Project AFS-44, 18 (AFS-44-3):1-54, Juneau.

Nelson, D, C. 1978. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1977-1978, Project AFS-44, 19 (AFS-44-4):1-57, Juneau.

Nelson, D, C. 1979. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1978-1979, Project AFS-44, 20 (AFS-44-5):1-60, Juneau.

Nelson, D, C. 1980. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1979-1980, Project AFS-44, 21 (AFS-44-6):1-47, Juneau.

Nelson, D, C. 1981. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1980-1981, Project AFS-44, 22 (AFS-44-7):1-48, Juneau.

Nelson, D, C. 1982. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1981-1982, Project AFS-44, 23 (AFS-44-8):1-48, Juneau.

Nelson, D, C. 1983. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1982-1983, Project AFS-44, 24 (AFS-44-9):1-50, Juneau.

Nelson, D, C. 1984. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1983-1984, Project F-9-16, 25 (G-II-C):1-66, Juneau.

LITERATURE CITED (Continued)

Nelson, D, C. 1985. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1984-1985, Project F-9-17, 26 (G-II-C):1-59, Juneau.

Nelson, D. C., D. E. Athons, and J. A. Carlon. 1986. Russian River sockeye salmon study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project AFS-44, 27 (AFS-44-11):1-59, Juneau.

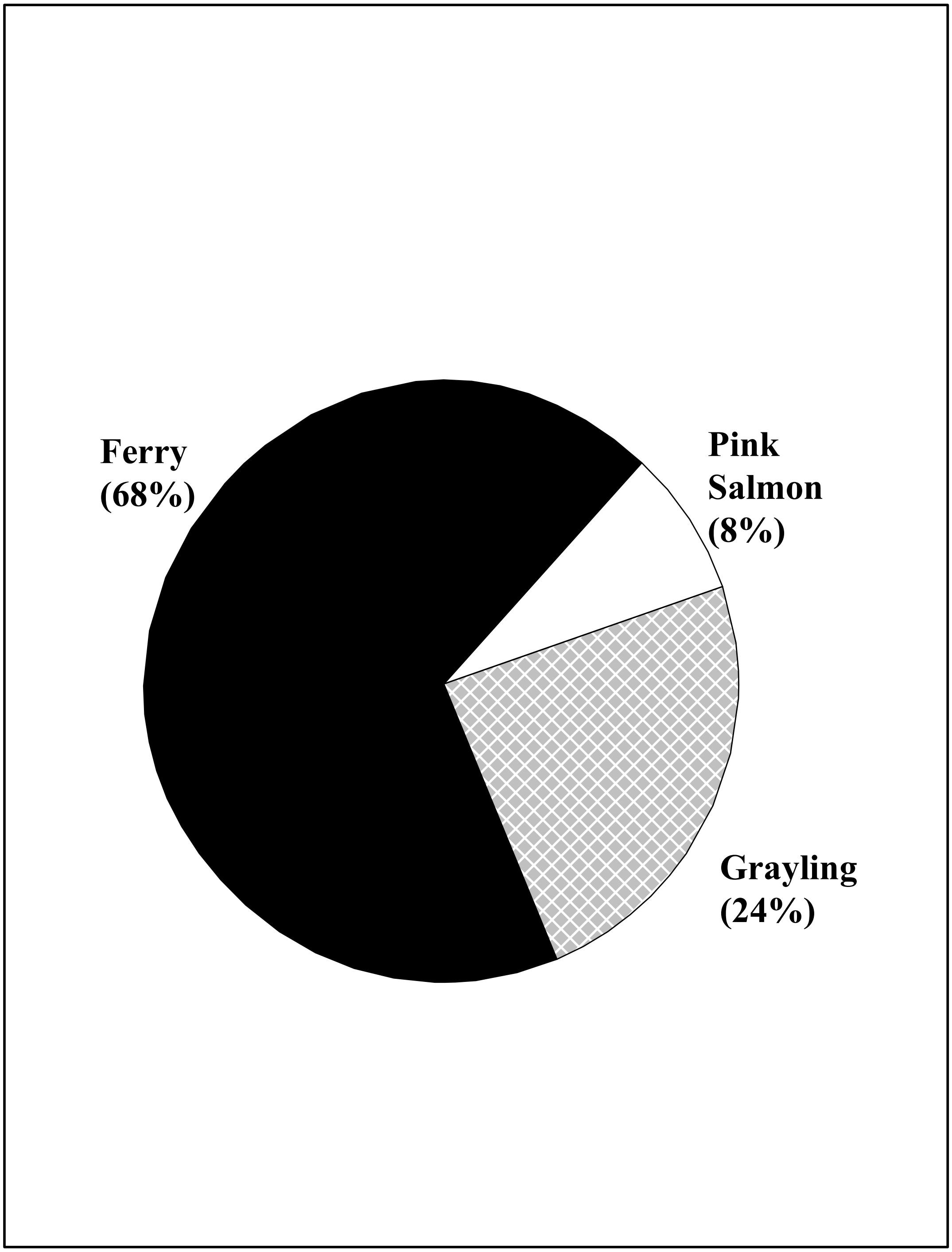
Neuhold, J. M. and H. K. Lu. 1957. Creel census methods. Utah Department of Fish and Game Publication No. 8. Salt Lake City.

Scheaffer, R. L., W. Mendenhall, and L. Ott. 1979. Elementary survey sampling. Duxbury Press. North Scituate, Massachusetts.

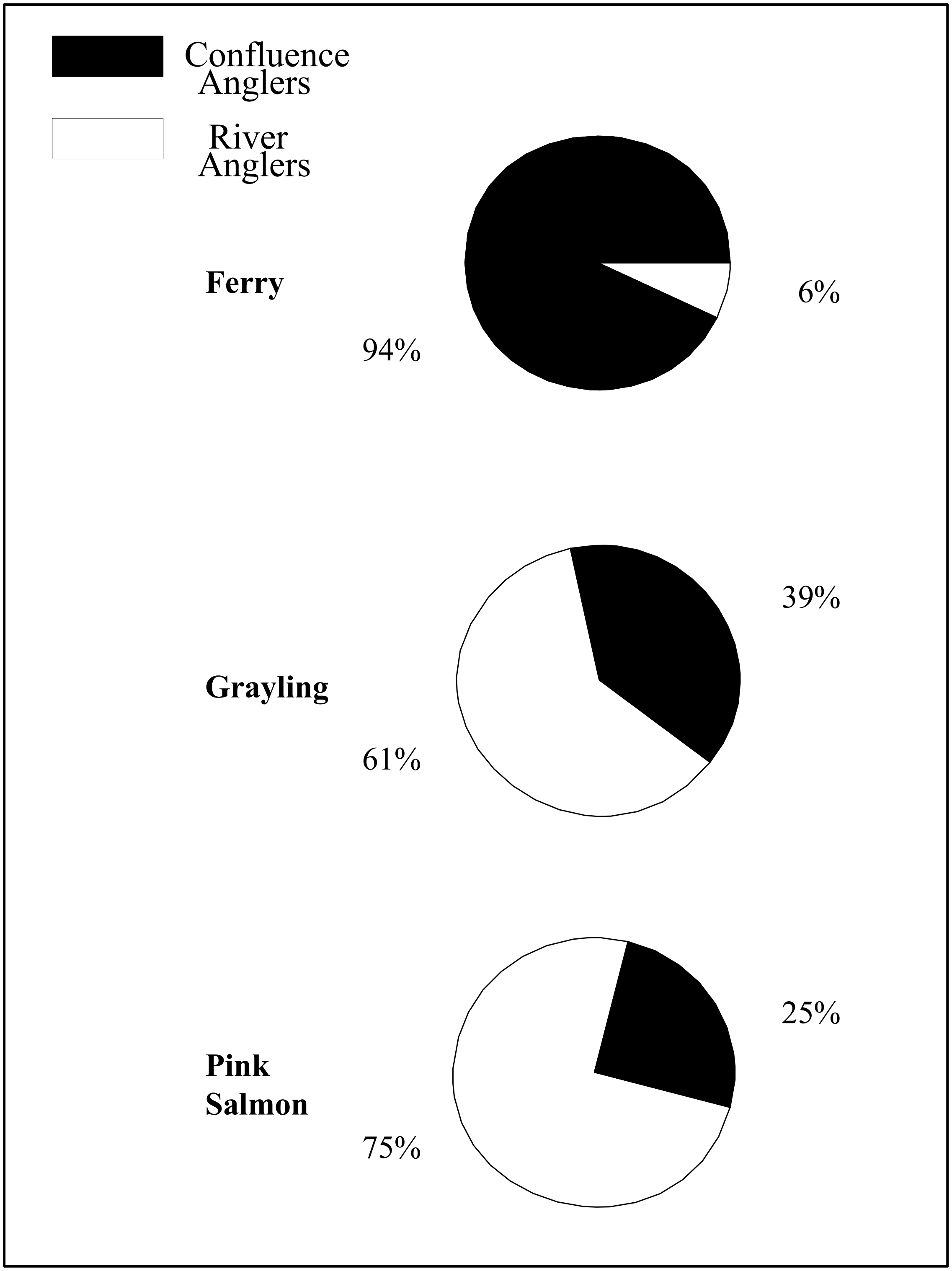
Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, second edition. Charles Griffin and Company Ltd., London.

Vincent-Lang, D. and J. A. Carlon. 1991. Development and implementation of escapement goals for the early return of sockeye salmon to the Russian River, Alaska. Alaska Department of Fish and Game, Fishery Manuscript Series No. 91-1, Anchorage.

APPENDIX A. SELECTED SUMMARIES OF FISHERY AND ESCAPEMENT DATA FROM THE RUSSIAN RIVER, 1994.



Appendix A1.-Relative proportions of interviews collected at the sampled access locations to the Russian River sockeye salmon recreational fishery, early run, 1994.



Appendix A2.-Relative proportions of confluence and river anglers interviewed during the Russian River creel survey by access location, early run, 1994.

Appendix A3.-Temporal harvest and effort estimates for the 1994 early-run Russian River sockeye salmon recreational fishery by area and access location.

Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance Components Days	%	Periods	%	Anglers	%
River Effort:													
Ferry	6/11-6/29	19	10	226	42,274	4,300	1,600,731	722,886	45	874,589	55	3,256	0
Grayling	6/11-6/29	14	6	1,042	479,058	14,583	10,999,763	8,942,415	81	2,012,773	18	44,575	0
Pink Salmon	6/11-6/29	14	4	509	44,190	7,129	2,502,606	1,546,634	62	950,512	38	5,460	0
					Total 6/11 - 6/29	26,012	15,103,100						
Ferry	6/30-7/19	20	10	63	27,627	1,269	899,709	552,540	61	344,847	38	2,322	0
Grayling	6/30-7/19	20	8	745	22,794	14,908	3,257,155	683,835	21	2,517,440	77	55,880	2
Pink Salmon	6/30-7/19	20	6	273	17,437	5,453	1,004,978	813,736	81	188,524	19	2,718	0
					Total 6/30 - 7/19	21,630	5,161,842						
					Total River Effort	47,642	20,264,942						
Confluence Effort:													
Ferry	6/11-6/29	19	10	2,428	908,304	46,123	27,385,089	15,531,996	57	11,831,166	43	21,927	0
Grayling	6/11-6/29	14	6	328	41,838	4,587	888,276	780,976	88	104,050	12	3,250	0
Pink Salmon	6/11-6/29	14	4	197	11,050	2,752	502,338	386,756	77	115,132	23	450	0
					Total 6/11 - 6/29	53,462	28,775,703						
Ferry	6/30-7/19	20	10	3,025	3,121,851	60,491	105,795,857	62,437,016	59	43,215,900	41	142,940	0
Grayling	6/30-7/19	20	8	655	110,781	13,092	3,519,166	3,323,431	94	165,516	5	30,219	1
Pink Salmon	6/30-7/19	20	6	174	53,689	3,487	2,747,450	2,505,488	91	237,516	9	4,445	0
					Total 6/30 - 7/19	77,070	112,062,473						
					Total Confluence Effort	130,532	140,838,176						
					Total Effort	178,174	161,103,118						

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Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance Components Days	%	Periods	%	Anglers	%
River Harvest:													
Ferry	6/11-6/29	19	10	58	5,364	1,110	132,393	91,729	69	39,581	30	1,083	1
Grayling	6/11-6/29	14	6	227	53,243	3,175	1,367,639	993,877	73	365,127	27	8,635	1
Pink Salmon	6/11-6/29	14	4	74	6,792	1,043	264,667	237,731	90	25,802	10	1,134	0
					Total 6/11 - 6/29	5,328	1,764,699						
Ferry	6/30-7/19	20	10	14	990	283	29,760	19,798	67	9,495	32	468	2
Grayling	6/30-7/19	20	8	229	31,469	4,580	1,233,530	944,072	77	277,012	22	12,447	1
Pink Salmon	6/30-7/19	20	6	23	605	461	32,416	28,220	87	4,086	13	110	0
					Total 6/30 - 7/19	5,324	1,295,706						
					Total River Harvest	10,652	3,060,405						
Confluence Harvest:													
Ferry	6/11-6/29	19	10	603	52,827	11,453	1,474,211	903,348	61	558,569	38	12,293	1
Grayling	6/11-6/29	14	6	70	5,658	985	108,173	105,623	98	1,242	1	1,309	1
PinkSalmon	6/11-6/29	14	4	54	1,071	758	49,597	37,499	76	11,433	23	665	1
					Total 6/11 - 6/29	13,196	1,631,981						
Ferry	6/30-7/19	20	10	918	148,641	18,358	6,210,787	2,972,826	48	3,203,703	52	34,258	1
Grayling	6/30-7/19	20	8	305	59,771	6,105	1,917,545	1,793,122	94	114,499	6	9,924	1
PinkSalmon	6/30-7/19	20	6	31	1,458	612	88,326	68,017	77	19,300	22	1,008	1
					Total 6/30 - 7/19	25,075	8,216,658						
					Total Confluence Harvest	38,271	9,848,639						
					Total Harvest	48,923	12,909,044						

[a] D = number of days possible in a stratum.

[b] d = number of days sampled in a stratum.

Appendix A4.-Daily escapement of early- and late-run sockeye salmon and chinook salmon through the Russian River weir, 10 June to 1 August 1994.

Date	Early-Run Sockeye[a]	Late-Run Sockeye[a]	Chinook[b]
6/10	0		
6/11	0		
6/12	0		
6/13	0		
6/14	0		
6/15	0		
6/16	0		
6/17	62		
6/18	91		
6/19	96		
6/20	98		
6/21	319		
6/22	95		
6/23	404		
6/24	1,178		
6/25	418		
6/26	3,170		
6/27	3,412		
6/28	3,258		
6/29	2,498		
6/30	1,790		
7/1	2,409		
7/2	1,822		
7/3	2,039		
7/4	2,848		
7/5	1,821		
7/6	1,594		
7/7	1,219		
7/8	3,221		
7/9	1,626		
7/10	357		
7/11	1,568		
7/12	568		
7/13	1,275		
7/14	422		
7/15	442	15	
7/16	1,725	20	
7/17	716	13	
7/18	535	14	
7/19	204	12	
7/20	84	13	
7/21	173	59	

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Date	Early-Run Sockeye[a]	Late-Run Sockeye[a]	Chinook[b]
7/22	65	16	
7/23	76	5	
7/24	153	18	
7/25	247	84	
7/26	146	120	
7/27	192	623	
7/28	191	1,572	
7/29	159	3,851	
7/30	21	2,428	1
7/31	45	679	1
8/1	20	4,214	1
Total	44,872		

[a] From 7/15 through 8/01, early-run fish were differentiated from late-run fish based on degree of external maturation, i.e., body coloration and kype development. There was a 18-day overlap between early-run and late-run fish. The total late-run sockeye salmon escapement is tabulated in the Fisheries Data Series report for the 1994 late-run to the Russian River (Marsh *In prep*).

[b] Total estimated chinook escapement is tabulated in the Fishery Data Series report for the 1994 late-run to the Russian River (Marsh *In prep*).